ENVIRONMENTAL MONITORING

SEMIANNUAL REPORT

JULY 1, 1967 TO DECEMBER 31, 1967

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by

J. D. Moore

APPROVED: _____

R. E. Alexander
Supervisor, Radiation Safety Unit

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ABSTRACT

Environmental monitoring at Atomics International is performed by the Radiation Safety Unit of the Health, Safety, and Radiation Services Department. Soil, vegetation, water, and air are routinely sampled up to a distance of 10 miles from Atomics International property. The environmental radioactivity reported herein is attributed to natural causes and to nuclear weapons testing, rather than to Atomics International operations.

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I. SUMMARY

Atomics International, A Division of North American Rockwell Corporation, has been engaged in atomic energy research and development since 1946. The Company designs, develops, and constructs nuclear reactors for central station and compact power plants and for medical, industrial, and scientific applications.

The Company occupies modern facilities in Canoga Park, California, approximately 23 miles northwest of downtown Los Angeles (Figure 1). The 290-acre Nuclear Development Field Laboratory (Figure 2), equipped with extensive facilities for the support of advanced nuclear studies, is located in the Simi Hills of Ventura County approximately 29 miles northwest of downtown Los Angeles. The location of the sites in relation to nearby communities is shown in Figure 3.

The basic concept of radiological hazards control at Atomics International requires adequate containment of radioactive materials, and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a measure of the effectiveness of the Company's radiological safety procedures and of engineering safeguards incorporated into facility designs.

Environmental sampling stations located within the boundaries of Atomics International's sites are referred to as "on-site" stations. The remaining stations, located within a 10-mile radius of the sites, are referred to as "off-site" stations. The on-site environs of Atomics International's Headquarters and Nuclear Development Field Laboratory (NDFL) facilities are sampled monthly to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The off-site environs are also sampled monthly; however, since January, 1966, analysis of off-site soil and vegetation samples has been performed only quarterly. Also, continuous on-site environmental air sampling provides information concerning long-lived airborne particulate radioactivity. This report summarizes environmental monitoring results for the last six months of 1967 and compares the data for 1967 with previous years.

A. ENVIRONMENTAL RADIOACTIVITY DATA - 1967

The average radioactivity concentrations in soil and vegetation samples are presented in Tables I and II.

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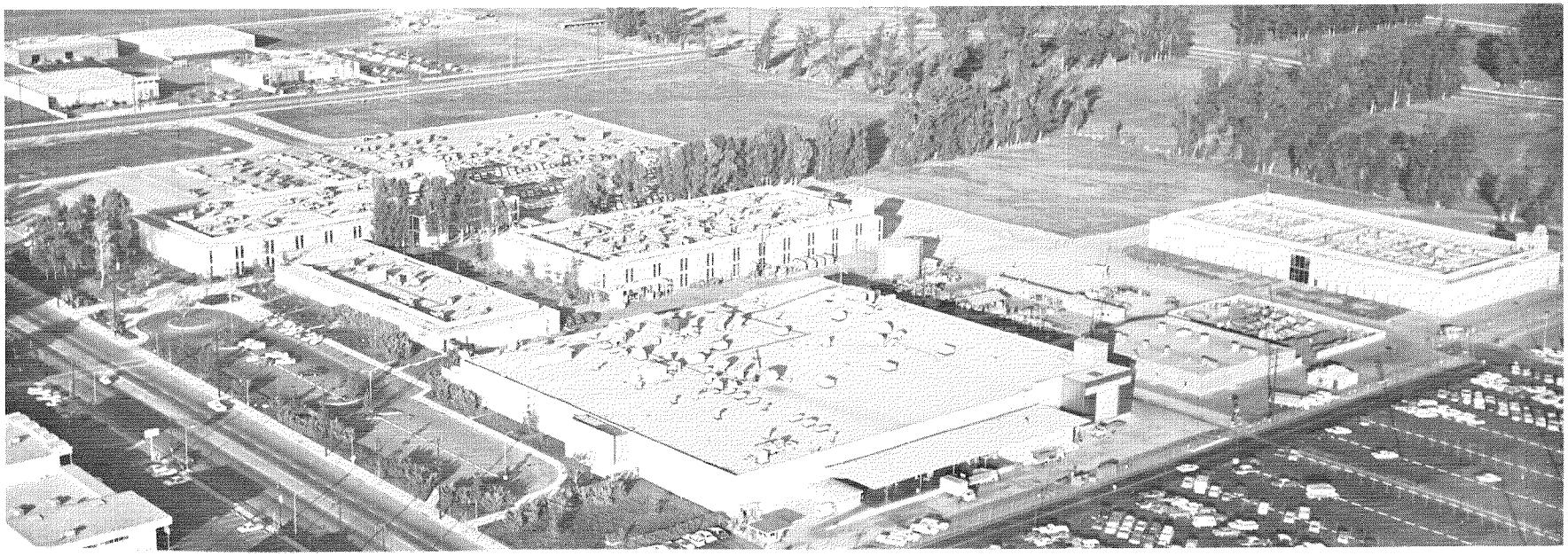

Figure 1. Atomics International Headquarters

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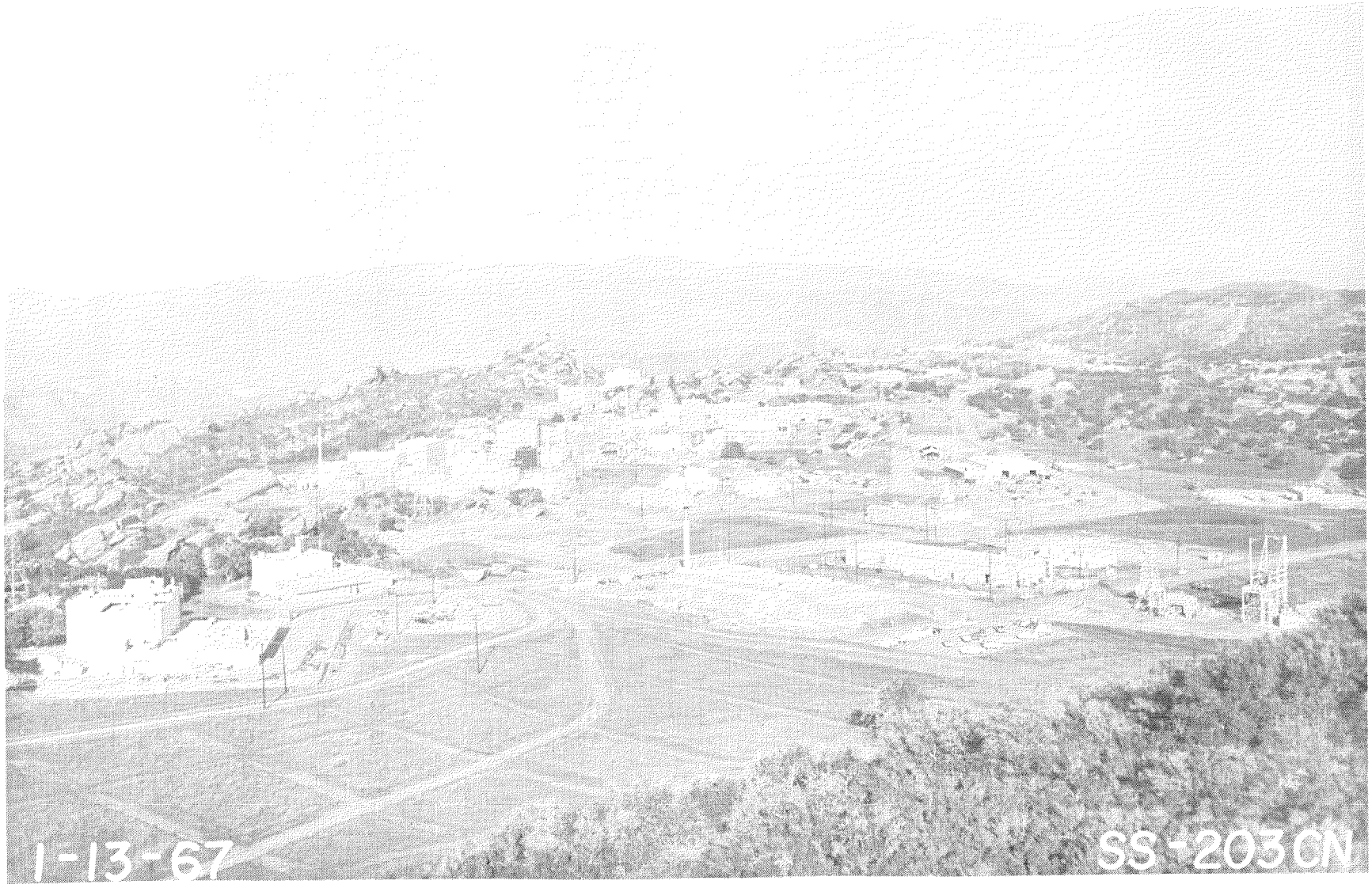

Figure 2. Atomics International Nuclear Development Field Laboratory.

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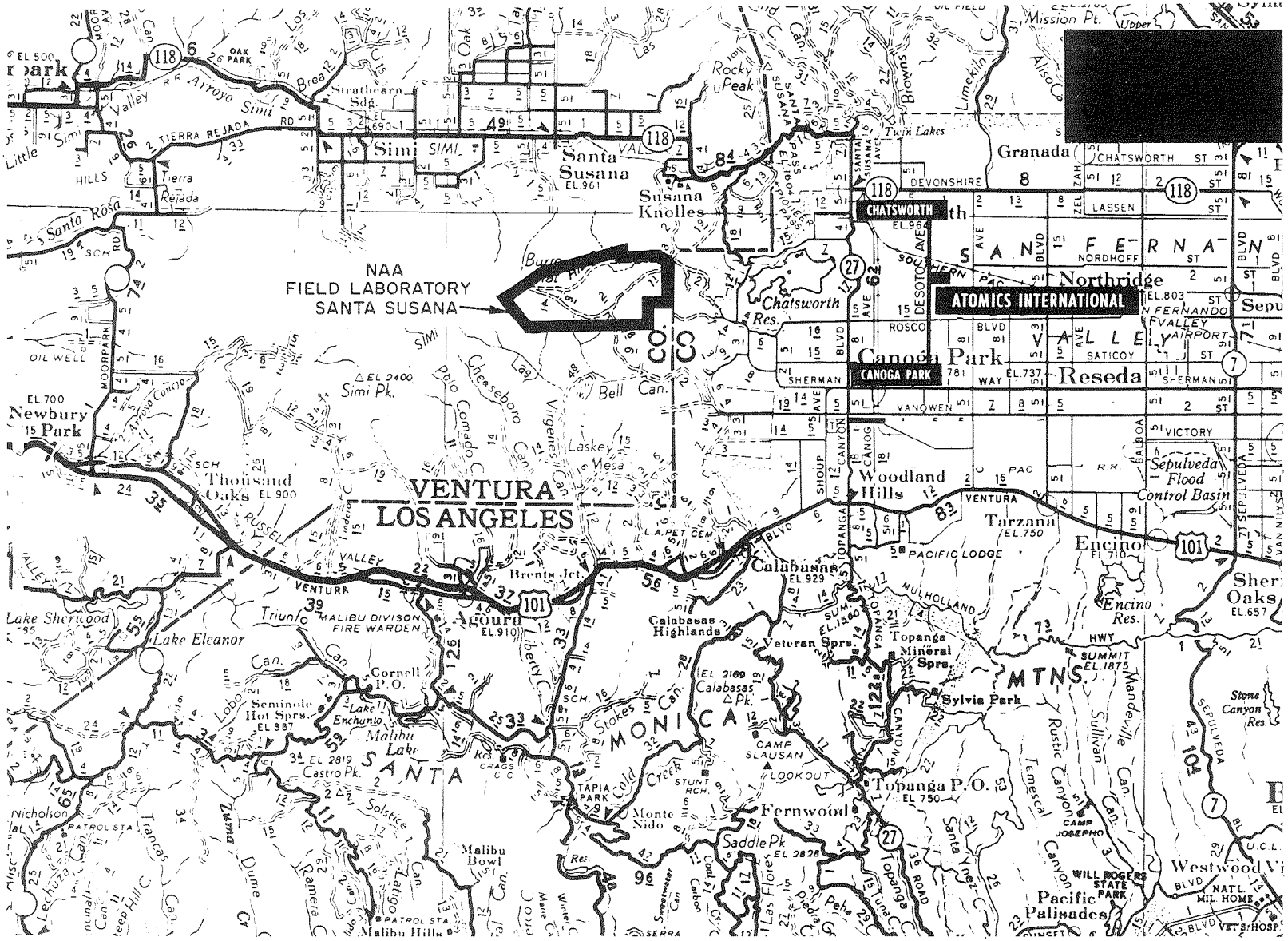

Figure 3. Map of Headquarters and Nuclear Development Field Laboratory Environs.

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TABLE I.
SOIL RADIOACTIVITY DATA - 1967

Area	Activity	First Half - 1967		Last Half - 1967	
		No. Samples	Average μμCi/gram	No. Samples	Average μμCi/gram
On Site	α	72	0.39 to 0.40	72	0.43
	β-γ	72	27	72	28
Off Site	α	24	0.36 to 0.37	24	0.41
	β-γ	24	25	24	24

TABLE II.
VEGETATION RADIOACTIVITY DATA - 1967

Area	Activity	First Half - 1967		Last Half - 1967	
		No. Samples	Average μμCi/gram-ash	No. Samples	Average μμCi/gram-ash
On Site	α	72	0.48 to 0.49	72	0.74
	β-γ	72	425	72	147
Off Site	α	24	0.32 to 0.33	24	0.44
	β-γ	24	658	24	167

Process water used at the NDFL is obtained from Ventura County Water District No. 10 and distributed on-site by the same piping system previously used when process water was supplied by on-site wells. Pressure is provided by elevated storage tanks, one 50,000-gallon and one 500,000-gallon tank on-site. While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the pipe system is sampled monthly at two locations. The average process water radioactivity concentration is presented in Table III.

TABLE III.
NDFL PROCESS WATER RADIOACTIVITY DATA - 1967

Area	Activity	First Half - 1967		Last Half - 1967	
		No. Samples	Average μμCi/liter	No. Samples	Average μμCi/liter
NDFL	α	12	0.08 to 0.10	12	0.15 to 0.16
	β-γ	12	6.8 *	12	5.5

* Erroneously reported as 3.4 μμCi/liter in the previous environmental monitoring semi-annual report for the period January 1, 1967 to June 30, 1967.

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Surface discharged waters from NDFL facilities drain into holding reservoirs on Rocketdyne PFL property. When full, the main reservoir is drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66-49 of September 21, 1966, an environmental sampling station has been established in Bell Creek Canyon approximately 3.4 miles downstream from the south North American Rockwell Corporation boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in the Rocketdyne reservoir and Bell Creek samples are presented in Table IV.

Soil, vegetation, and water are sampled monthly at the Chatsworth Reservoir, which is owned and operated by the Los Angeles City Department of Water and Power. Soil and vegetation radioactivity data for the reservoir are averaged into the off-site data presented in Tables I, II, VII, and VIII. Normally, one water sample is obtained from the lake surface and another obtained from the reservoir water supply inlet located on the north side of the lake. The average radioactivity concentrations in lake surface and supply water are presented in Table V.

Environmental air sampling for long-lived particulate radioactivity is performed continuously at both the Headquarters and NDFL sites. Air is drawn through a filter which is analyzed, after a 72-hour decay period, for long-lived radioactivity. The average concentration of long-lived beta-gamma radioactivity is presented in Table VI.

Table I shows no significant change during the last six months of 1967 in soil radioactivity. Table II shows moderate increases in vegetation alpha radioactivity and considerable decreases in vegetation beta-gamma radioactivity. Table III shows that NDFL process water alpha radioactivity increased slightly and that beta-gamma radioactivity decreased. Table IV shows that Bell Creek mud radioactivity increased slightly, that Bell Creek vegetation and water alpha radioactivity increased slightly and that the beta-gamma radioactivity concentrations decreased considerably. Table IV also shows small increases in reservoir stations' 6 and 12 water radioactivity concentrations, except for station 6 alpha radioactivity which decreased slightly. Table V shows that Chatsworth Reservoir water alpha radioactivity increased and that beta-gamma radioactivity decreased slightly during the last half of 1967. Table VI shows significant decreases in local airborne radioactivity concentrations during the same period.

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TABLE IV.

BELL CREEK AND ROCKETDYNE PFL RESERVOIR
RADIOACTIVITY DATA - 1967

Sample Description	First Half - 1967			Last Half - 1967		
	No. Samples	α	β-γ	No. Samples	α	β-γ
Bell Creek Mud ($\mu\mu$Ci/gram)	6	0.38	24	6	0.41	25
Bell Creek Vegetation ($\mu\mu$Ci/gram-ash)	6	0.31 to 0.34	240	6	0.42	120
Bell Creek Water ($\mu\mu$Ci/liter)	6	0.04 to 0.07	7.3	6	0.08 to 0.09	4.0 to 4.4
Reservoir Station 6 Water ($\mu\mu$Ci/liter)	6	0.20	5.8	6	0.18	7.5
Reservoir Station 12 Water ($\mu\mu$Ci/liter)	6	0.09	6.5	6	0.16	7.0

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TABLE V.
CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA - 1967

Sample Type	Activity	First Half - 1967		Last Half - 1967	
		No. Samples	Average μμCi/liter	No. Samples	Average μμCi/liter
Lake Surface	α	6	0.29	6	0.32
	β-γ	6	8.7	6	7.6
Supply Inlet	α	6	0.26	6	0.30
	β-γ	6	6.5	6	5.5

TABLE VI.
AIRBORNE RADIOACTIVITY DATA - 1967

Location	Activity	First Half - 1967		Last Half - 1967	
		No. Samples	Average μμCi/m^3	No. Samples	Average μμCi/m^3
Headqtrs.	β-γ	353	0.68	359	0.09 to 0.11
NDFL	β-γ	1243	0.66	1157	0.11 to 0.13

B. COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1967 WITH PREVIOUS YEARS

This section summarizes the environmental monitoring results for the calendar year 1967. Also, the annual averages for the years 1958 through 1966 are included with the exception of the Rocketdyne Reservoir, Bell Canyon, and Chatsworth Reservoir. The annual average radioactivity in soil and vegetation is presented in Tables VII and VIII.

TABLE VII
SOIL RADIOACTIVITY DATA - 1958 THROUGH 1967

VII. a. Alpha Radioactivity

Year	On Site		Off Site	
	No. Samples	Average μμCi/gram	No. Samples	Average μμCi/gram
1967	144	0.41 to 0.42	48	0.38 to 0.39
1966	144	0.40 to 0.41	48	0.43 to 0.44
1965	144	0.46	142	0.46 to 0.47
1964	152	0.44 to 0.46	299	0.40 to 0.44
1963	156	0.41 to 0.43	455	0.38 to 0.42
1962	147	0.42 to 0.44	453	0.35 to 0.41
1961	120	0.30 to 0.37	458	0.24 to 0.33
1960	115	0.34 to 0.41	362	0.27 to 0.37
1959	107	0.43	377	0.32
1958	80	0.27	309	0.26

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VII. b. Beta-Gamma Radioactivity

Year	On Site		Off Site	
	No. Samples	Average μμCi/gram	No. Samples	Average μμCi/gram
1967	144	28	48	24
1966	142	29	48	25
1965	144	36	142	29
1964	146	32	293	26
1963	156	45	455	42
1962	147	48	453	47
1961	120	34	458	23
1960	114	23	360	19
1959	107	15	379	14
1958	84	21	318	10

TABLE VIII.
VEGETATION RADIOACTIVITY DATA - 1958 THROUGH 1967

VIII. a. Alpha Radioactivity

Year	On Site		Off Site	
	No. Samples	Average μμCi/gram-ash	No. Samples	Average μμCi/gram-ash
1967	144	0.61 to 0.62	48	0.38 to 0.39
1966	144	0.37	48	0.37
1965	144	0.55 to 0.56	142	0.61
1964	154	0.49 to 0.50	293	0.50 to 0.51
1963	156	0.43 to 0.44	456	0.36 to 0.37
1962	147	0.44 to 0.45	453	0.42 to 0.44
1961	120	0.32 to 0.35	459	0.26 to 0.29
1960	115	0.31 to 0.35	362	0.21 to 0.25
1959	96	0.29	293	0.18
1958	65	0.57	250	0.39

VIII. b. Beta-Gamma Radioactivity

Year	On Site		Off Site	
	No. Samples	Average μμCi/gram-ash	No. Samples	Average μμCi/gram-ash
1967	144	286	48	413
1966	144	169	48	123
1965	144	162	142	138
1964	148	211	299	181
1963	156	465	456	388
1962	147	500	453	406
1961	120	224	459	246
1960	113	137	358	136
1959	107	212	380	168
1958	84	683	318	356

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The annual average radioactivity in NDFL process water is presented in Table IX.

TABLE IX.
NDFL PROCESS WATER RADIOACTIVITY DATA - 1958 THROUGH 1967

Year	Alpha		Beta-Gamma	
	No. Samples	Average μμCi/liter	No. Samples	Average μμCi/liter
1967	24	0.12 to 0.13	24	6.1
1966	24	0.12 to 0.13	24	4.4 to 4.8
1965	24	0.21 to 0.22	24	5.9 to 6.0
1964	23	0.16 to 0.18	23	5.1 to 5.3
1963	24	0.17 to 0.18	24	6.9 to 7.0
1962	24	0.20 to 0.21	24	12
1961	24	0.06 to 0.09	24	2.2 to 3.6
1960	22	0.06 to 0.09	22	1.0 to 2.7
1959	18	0.08	16	1.6
1958	13	0.16	18	4.7

The annual average radioactivity in the Rocketdyne PFL Reservoir and Bell Creek samples is presented in Table X.

TABLE X.
BELL CREEK AND ROCKETDYNE PFL RESERVOIR
RADIOACTIVITY DATA

Sample Description	1966			1967		
	No. Samples	α	β-γ	No. Samples	α	β-γ
Bell Creek Mud (μμCi/gram)	3	0.39	25	12	0.40	24
Bell Creek Vegetation (μμCi/gram-ash)	3	1.12 to 1.14	108	12	0.37 to 0.38	180
Bell Creek Water (μμCi/liter)	3	0.60 to 0.90	0 to 2.5	12	0.06 to 0.08	5.7 to 5.9
Reservoir Station 6 Water (μμCi/liter)	9	0.10 to 0.12	5.8	12	0.19	6.6
Reservoir Station 12 Water (μμCi/liter)	8	1.0 to 1.1	6.3	10	0.16 to 0.17	7.0

The annual average radioactivity in Chatsworth Reservoir water is presented in Table XI.

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TABLE XI.
CHATSWORTH RESERVOIR WATER RADIOACTIVITY DATA -
1961 THROUGH 1967

Year	Lake Surface			Supply Inlet		
	No. Samples	Average μμCi/liter		No. Samples	Average μμCi/liter	
		α	β-γ		α	β-γ
1967	12	0.31	8.1	12	0.28	6.0
1966	12	0.32	5.9	12	0.42	5.9
1965	11	0.65	8.7	12	0.61	8.8 to 9.1
1964	18	0.71	10	12	0.49	8.8
1963	37	0.84	18	12	0.57 to 0.58	9.0 to 9.2
1962	41	0.66 to 0.67	19	12	0.50	13
1961	38	0.52	11	10	0.28	7.7 to 8.0

The annual average concentrations of long-lived airborne radioactivity at Headquarters and the NDFL is presented in Table XII.

TABLE XII.
AIRBORNE RADIOACTIVITY DATA -
1958 THROUGH 1967
β-γ

Year	Headquarters		NDFL	
	No. Samples	Average μμCi/m^3	No. Samples	Average μμCi/ m^3
1967	712	0.38 to 0.40	2400	0.40 to 0.41
1966	706	0.17 to 0.18	2205	0.16 to 0.17
1965	483	0.83	1062	0.21
1964	355	2.7	Insufficient Data	
1963	360	6.6	292	4.7
1962	343	7.3	314	5.6
1961	313	4.2	176	3.6
1960	182	0.24	44	0.44
1959	215	2.5	257	0.93
1958	366	4.9	164	2.7

Some of the data presented in the Tables are presented as a range within which lies the true average. This is necessary when one or more of the samples contain an "undetectable" amount of radioactivity. In these instances, two values are determined. The lowest assumes that the "undetectable" samples contain no radioactivity; the highest assumes that these samples contain radioactivity equal to the appropriate minimum detection limit specified in Table XIV.

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Radioactivity concentrations in most environmental sample types are generally commensurate with the concentrations experienced during 1966; however, two exceptions are vegetation and airborne radioactivity. The increased radioactivity in these sample types is not attributed to Atomics International's operations; rather it is felt to have been produced after September 1, 1961, by several world-wide nuclear detonations.

II. ENVIRONMENTAL MONITORING PROGRAM

A. GENERAL DESCRIPTION

Soil and vegetation collection and analysis for radioactivity was initiated in 1952 in the Downey, California area where the Company was initially located. Environmental sampling was subsequently extended to the proposed Sodium Reactor Experiment (SRE) site in the Simi Hills in May of 1954. In addition, sampling was conducted in the Burro Flat area, southwest of SRE, where many nuclear installations are currently in operation. The Downey area survey was terminated when the Company relocated to Canoga Park. The primary purpose of the environmental monitoring program is to survey environmental radioactivity adequately to ensure that Atomics International operations do not contribute significantly to environmental radioactivity.

A study of past data showed that this purpose could be achieved with a less extensive environmental monitoring program than that which existed until July, 1964. Therefore, beginning with that month, the number of sampling stations was reduced considerably. In addition, since January, 1966, off-site environmental survey samples have been analyzed only quarterly; on-site samples continue to be analyzed monthly. The locations of sampling stations are shown in Figures 4, 5, 6, and 7, and in Table XIII.

B. SAMPLING AND SAMPLE PREPARATION METHODS

SOIL

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the top 1/2-inch layer of ground surface. The soil samples are packaged and sealed in plastic containers and returned to the laboratory for analysis.

Sample preparation consists of transferring the soils to pyrex beakers and drying in a muffle furnace at approximately 500°C for eight hours. After cooling, the soil is sieved to obtain uniform particle size. One-gram aliquots of the sieved soil are weighed and transferred to stainless-steel planchets. The soil is wetted in the planchet with acetone, agitated to obtain uniform sample thickness, re-dried, and counted.

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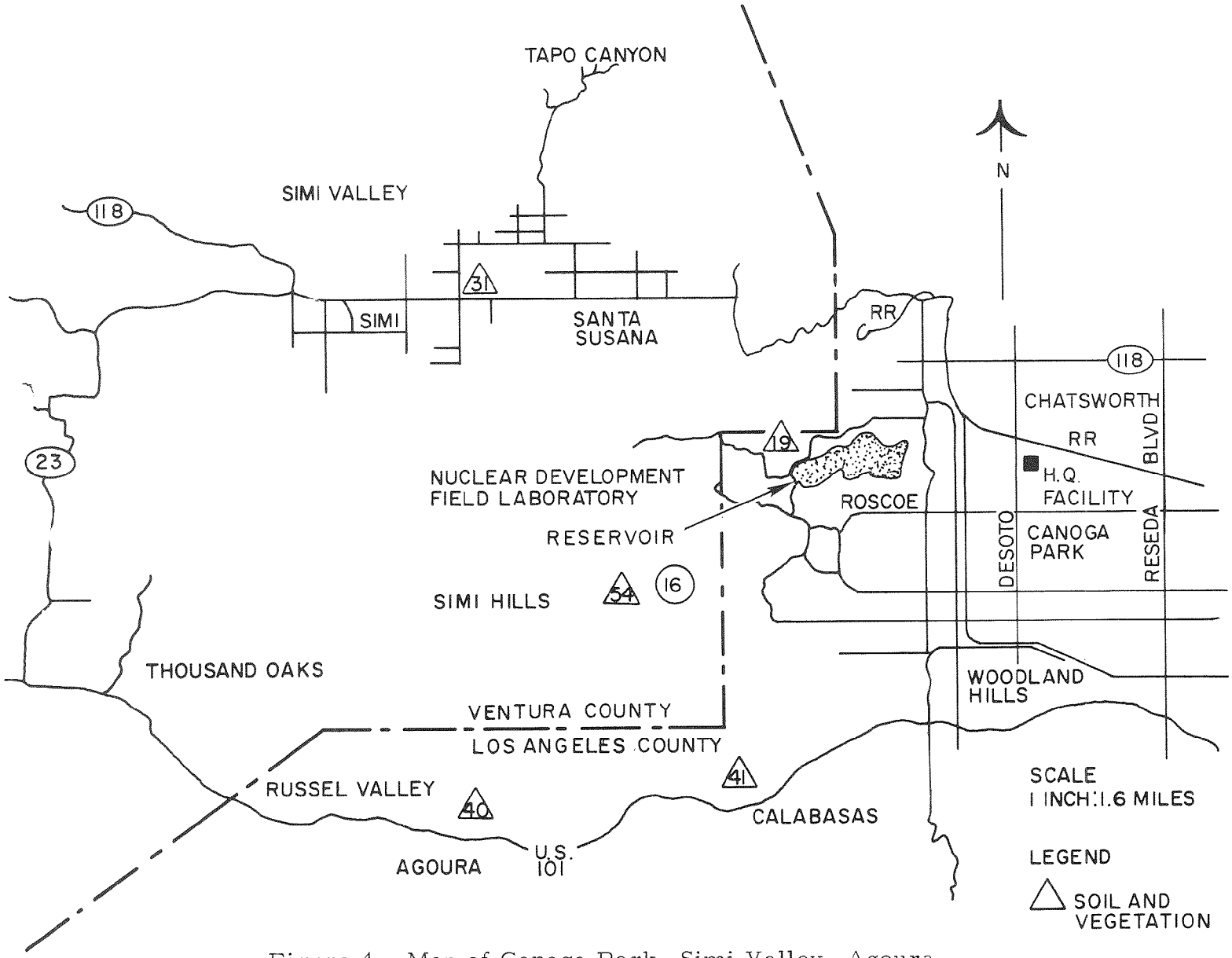

Figure 4. Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations

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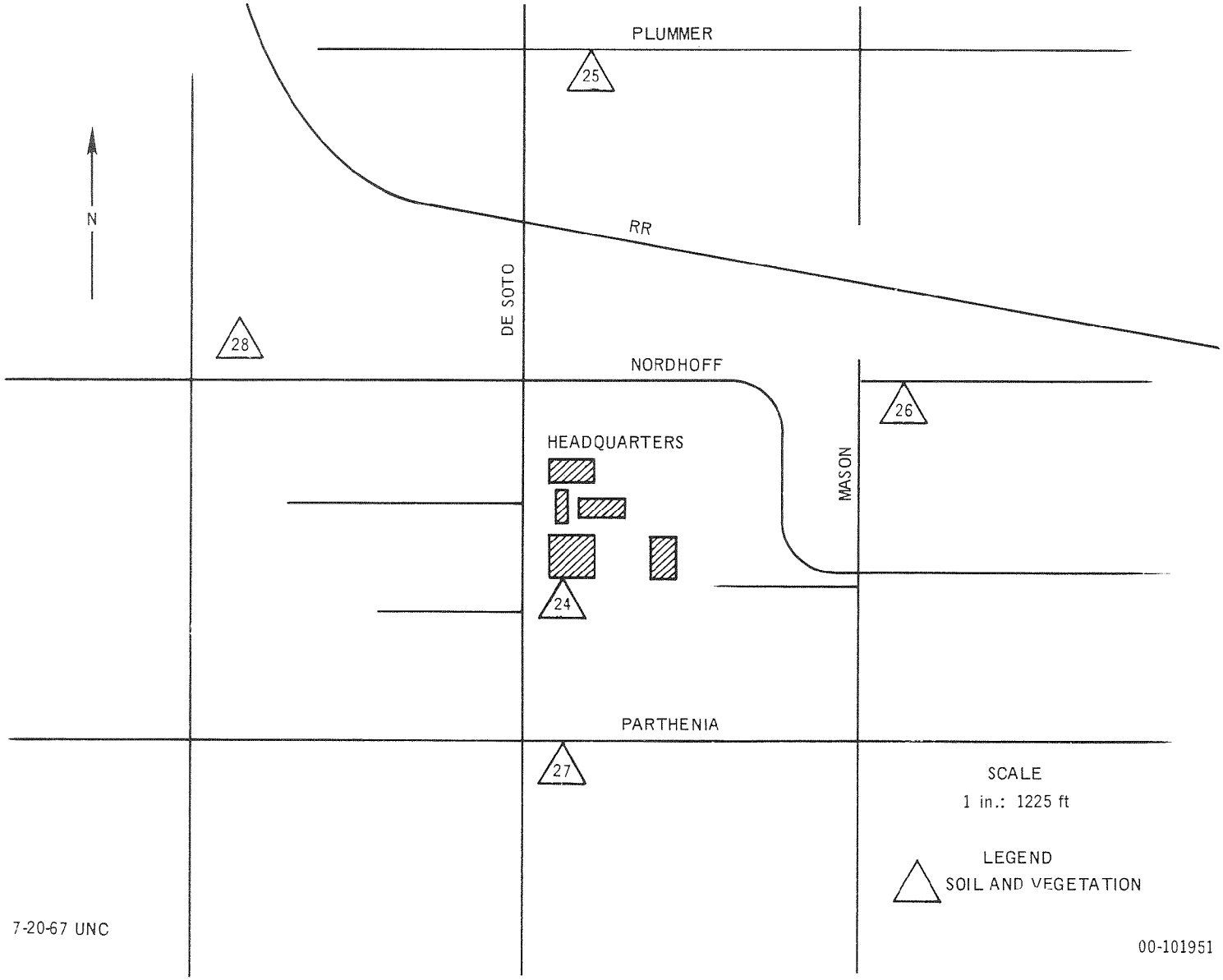

Figure 5. Map of Headquarters Vicinity Sampling Stations

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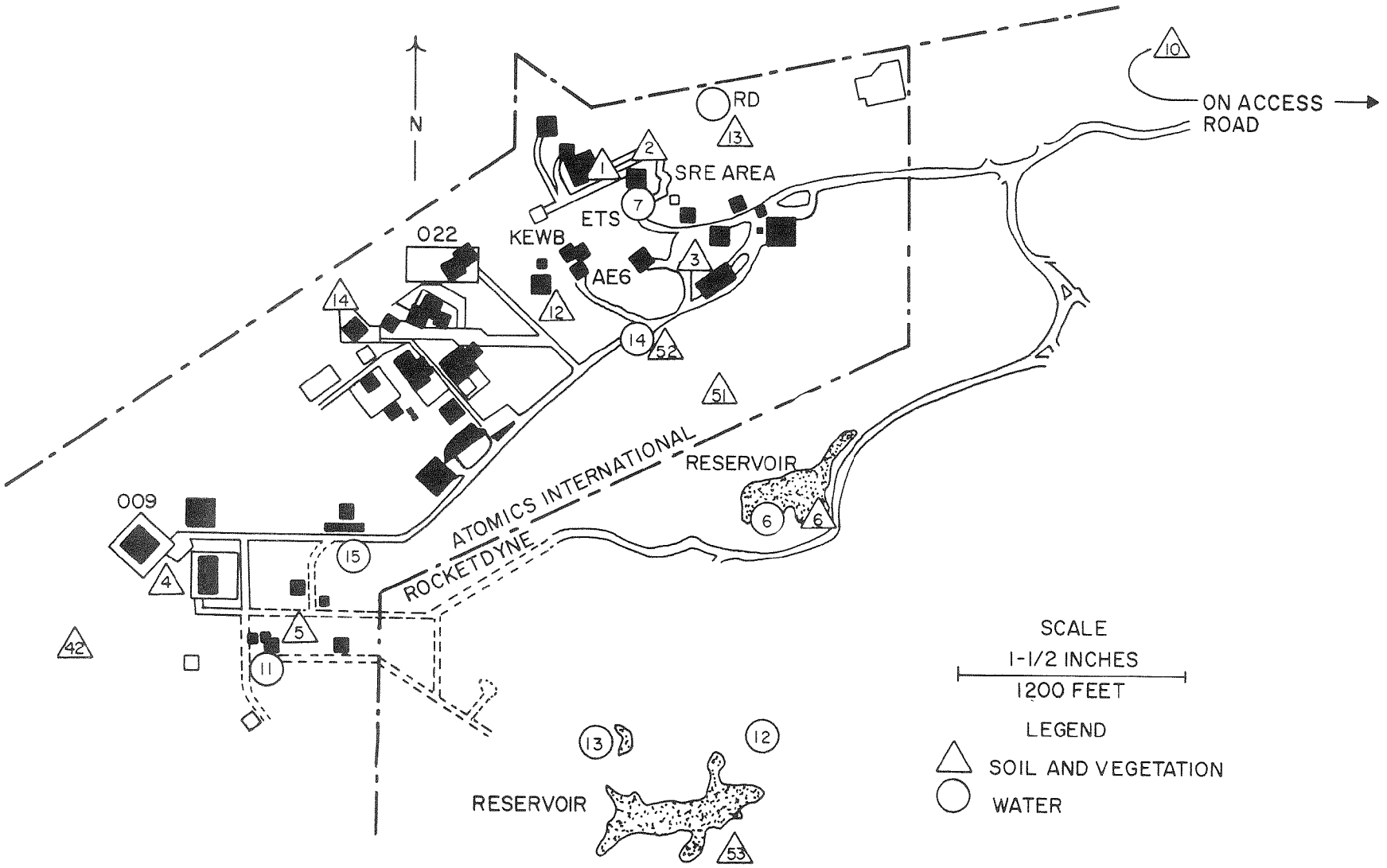

Figure 6. Map of NDFL Sampling Stations

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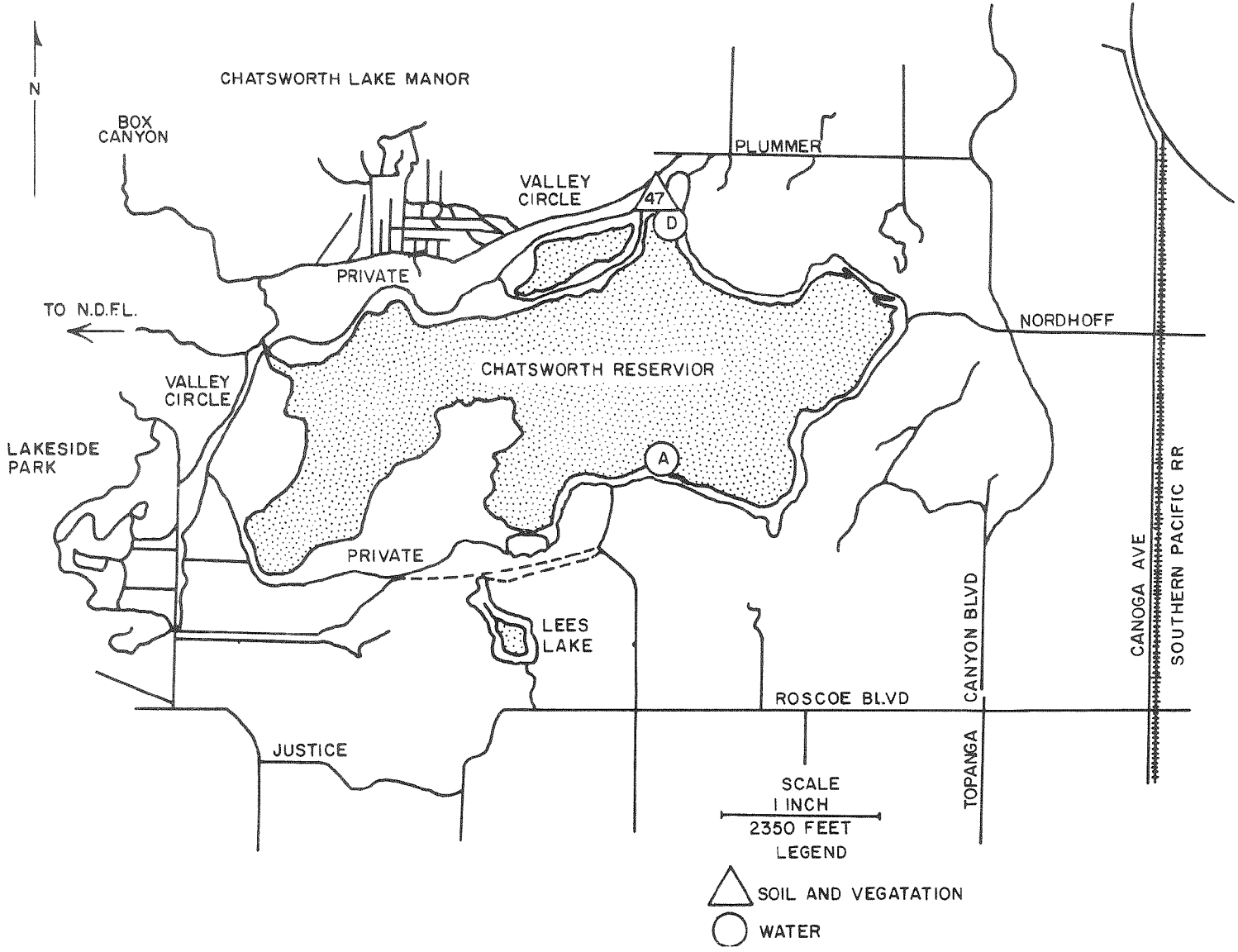

Figure 7. Map of Chatsworth Reservoir Sampling Stations

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VEGETATION

Vegetation samples obtained in the field are of the same plant type wherever possible, generally sunflower or wild tobacco leaves. These types maintain a more active growth rate during the dry season than does most natural vegetation indigenous to the local area. Vegetation leaves are stripped from plants and sealed in ice cream cartons for transfer to the laboratory for analysis. Plant root systems are not normally analyzed.

TABLE XIII.
SAMPLE STATION LOCATIONS

STATION	LOCATION
SV-1	SRE Reactor, NDFL
SV-2	SRE Perimeter Drainage Ditch, NDFL
SV-3	Bldg. 064 Parking Lot, NDFL
SV-4	Bldg. 020, NDFL
SV-5	Bldg. 363, NDFL
SV-6	Rocketdyne Reservoir, PFL
SV-10	Santa Susana Site Access Road
SV-12	KEWB Reactor, NDFL
SV-13	Sodium Cleaning Pad, NDFL
SV-14	Canyon Below Bldg. 022, NDFL
SV-19	Santa Susana Site Entrance, Woolsey Canyon
SV-24	Atomics International Headquarters
SV-25	De Soto Ave. and Plummer St.
SV-26	Nordhoff St. and Mason Ave.
SV-27	De Soto Ave. and Parthenia St.
SV-28	Canoga Ave. and Nordhoff St.
SV-31	Simi Valley, Los Angeles Ave. and Sycamore Road
SV-40	Agoura
SV-41	Calabasas
SV-42	Non-Radioactive Materials Disposal Area, NDFL
SV-47	Chatsworth Reservoir, North Side
SV-51	Bldg. 029, NDFL
SV-52	Burro Flat Drainage Control Pond, G. St. and 17th St., NDFL
SV-53	Top of Bell Canyon Below Rocketdyne Delta Pond Spillway, PFL
SV-54	Bell Creek
W-6	Rocketdyne Reservoir, PFL
W-7	Process Water from Bldg. 003, NDFL
W-11	Process Water from Bldg. 363, NDFL
W-12	Rocketdyne Reservoir, PFL
W-13	Rocketdyne Drainage Collection Pond, PFL
W-14	Burro Flat Drainage Control Pond, G. St., and 17th St., NDFL

Continued .....

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Table XIII. Sample Station Locations - Continued

STATION	LOCATION
W-15	Burro Flat Drainage Channel Adjacent to Bldg. 383
W-16	Bell Creek
W-A	Chatsworth Reservoir Surface, South Side
W-D	Chatsworth Reservoir, Supply Inlet
W-RD	SRE Retention Dam, NDFL

Vegetation samples are first washed with tap water to remove foreign matter, and then thoroughly rinsed with distilled water. Washed vegetation is placed in porcelain crucibles and ashed in a muffle furnace at approximately 500°C for eight hours, producing a completely burned ash. Three hundred milligram aliquots of pulverized ash from each crucible are weighed and transferred to stainless-steel planchets for counting.

WATER

Samples of process water are obtained monthly at the NDFL, from Bell Creek, and from the Chatsworth Reservoir. The water is drawn into one-liter polyethylene bottles and transferred to the laboratory.

Five hundred ml. of water are evaporated to dryness in crystallizing dishes at approximately 90°C. The residue salts are transferred to stainless-steel planchets, wetted with distilled water to produce a uniform sample distribution, re-dried under infra-red lamps, and counted.

AIR

Environmental air sampling is conducted continuously at the Headquarters and NDFL sites with automatic air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV-70 filter paper which is automatically changed at the end of each sampling period. The filters are removed from the sampler and counted after the radioactivity has decayed for at least 72 hours. The volume of a typical daily environmental air sample is approximately 20 cubic meters. The minimum detection limit, calculated at 2 σ counter background, is on the order of 0.04 uuCi/m^3.

When abnormally high airborne radioactivities are observed, the radioactivity decay data are plotted to determine the presence of short-lived isotopes other than naturally occurring radon, thoron, and daughters. If fall-out is suspected, the decay characteristics are observed. If the radioactivity decays as a function of $t^{-1.2}$, the data curve is extrapolated in order to determine the date of origin. This date is compared with the dates of publicized nuclear detonations to determine if the abnormal airborne radioactivity was caused by such detonations.

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A graph of daily averaged long-lived airborne radioactivity concentrations detected at the Headquarters and NDFL facilities during 1967 is presented in Figure 8. The graph shows the incidence of comparatively high airborne radioactivity concentration peaks during January, diminishing through March, and continuing through the year at relatively low concentrations until the last two days of the year when fallout, resulting from nuclear weapons testing, caused a significant increase in airborne radioactivity in the local area.

C. COUNTING AND CALIBRATION PROCEDURES

Environmental soil, vegetation, air, and water samples are counted for alpha and beta-gamma radioactivity in automatic proportional counting systems. The sample-detector configuration provides nearly a 2 π geometry. The detector has a thin window and is continually purged with a 90% argon, 10% methane counting gas. A pre-set count mode of operation is used for all samples; however, an overriding pre-set time is also used for alpha counting to prevent the unnecessarily long counting of samples with extremely low activities. The minimum detection limits shown in Table XIV were determined by using typical values for pre-set count, pre-set time, system efficiencies, background count rates (approximately 0.03 cpm α and 12 cpm $\beta-\gamma$), and sample size.

TABLE XIV.
MINIMUM DETECTION LIMITS

Sample	Activity	Minimum Detection Limits *
Soil	α	0.19 ± 0.038 ($\mu\mu$Ci/gram)
	$\beta-\gamma$	6.9 ± 1.1 ($\mu\mu$Ci/gram)
Vegetation	α	0.064 ± 0.076 ($\mu\mu$Ci/gram-ash)
	$\beta-\gamma$	13.8 ± 2.1 ($\mu\mu$Ci/gram-ash)
Water	α	0.038 ± 0.046 ($\mu\mu$Ci/liter)
	$\beta-\gamma$	2.5 ± 1.3 ($\mu\mu$Ci/liter)

* Standard error

Counting system efficiencies are determined routinely using RaD + E + F (with and without alpha absorbers) and K-40. Potassium-40, in the form of standard reagent grade KCl, is used to simulate soil and vegetation samples for purposes of calibration. It has a compound specific activity of approximately 830 dpm per gram KCl and a beta energy of 1.33 mev. Its advantages are purity, long half-life, crystalline form, and low cost. A seeming disadvantage is its beta energy which is somewhat higher than that expected in environmental samples; however, the error introduced by this higher energy has been determined to be insignificant.

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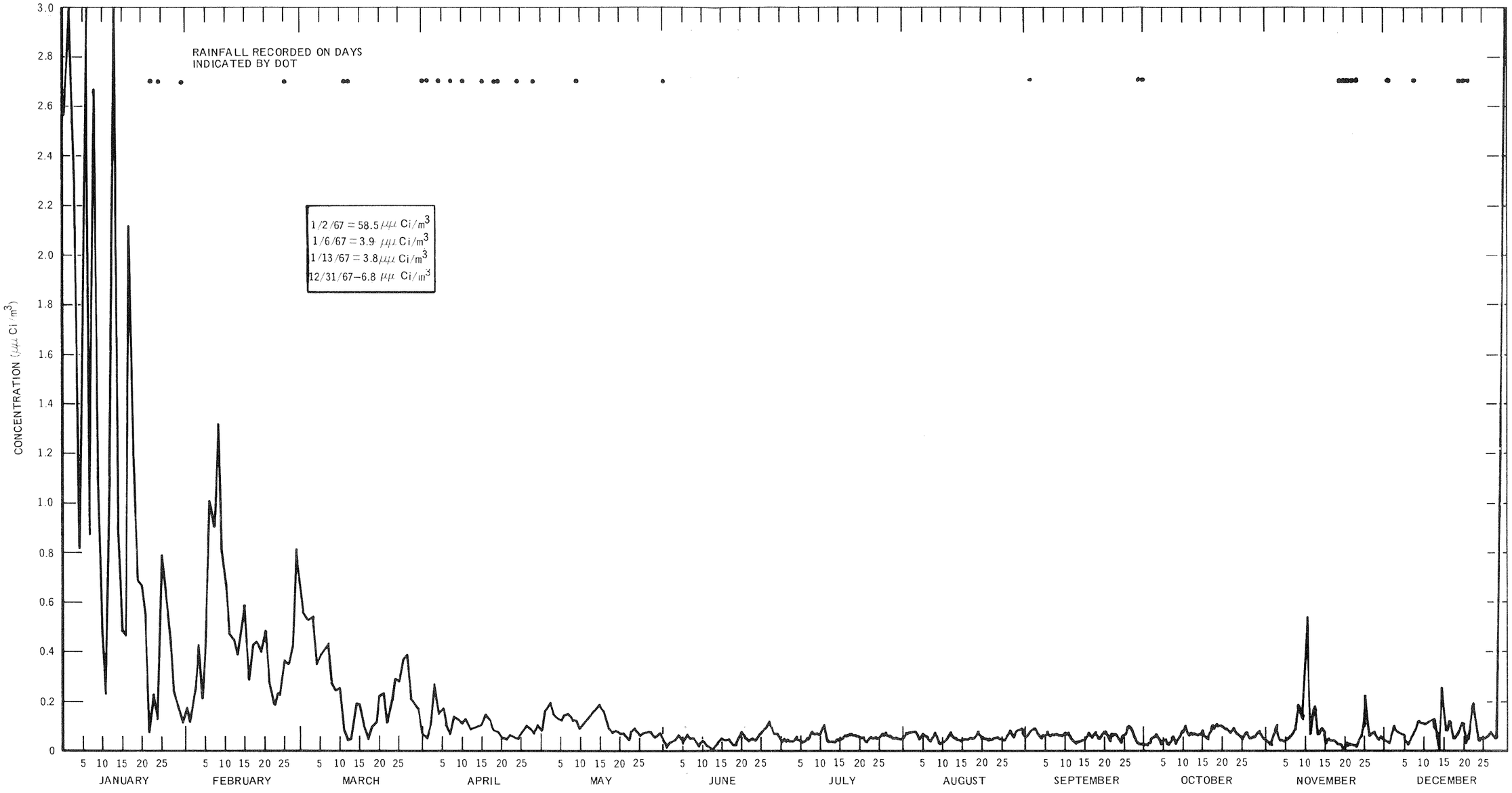

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Figure 8. Long-Lived Airborne Radioactivity
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In practice, KCl is sieved and divided into aliquots, increasing each in 100-milligram increments from 100 to 1200 milligrams. These aliquots are placed in stainless-steel planchets of the type used for soil and vegetation samples and counted with the proportional counting system. The ratio of sample activity to observed net counting rate for each aliquot is plotted as a function of aliquot weight (see Figure 9). The correction factor (ratio) corresponding to each soil or vegetation sample weight is obtained from this graph. The product of the correction factor and the net sample counting rate yields the sample activity (dpm). This method has been proved usable by applying it to variously sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fall within the expected statistical counting error.

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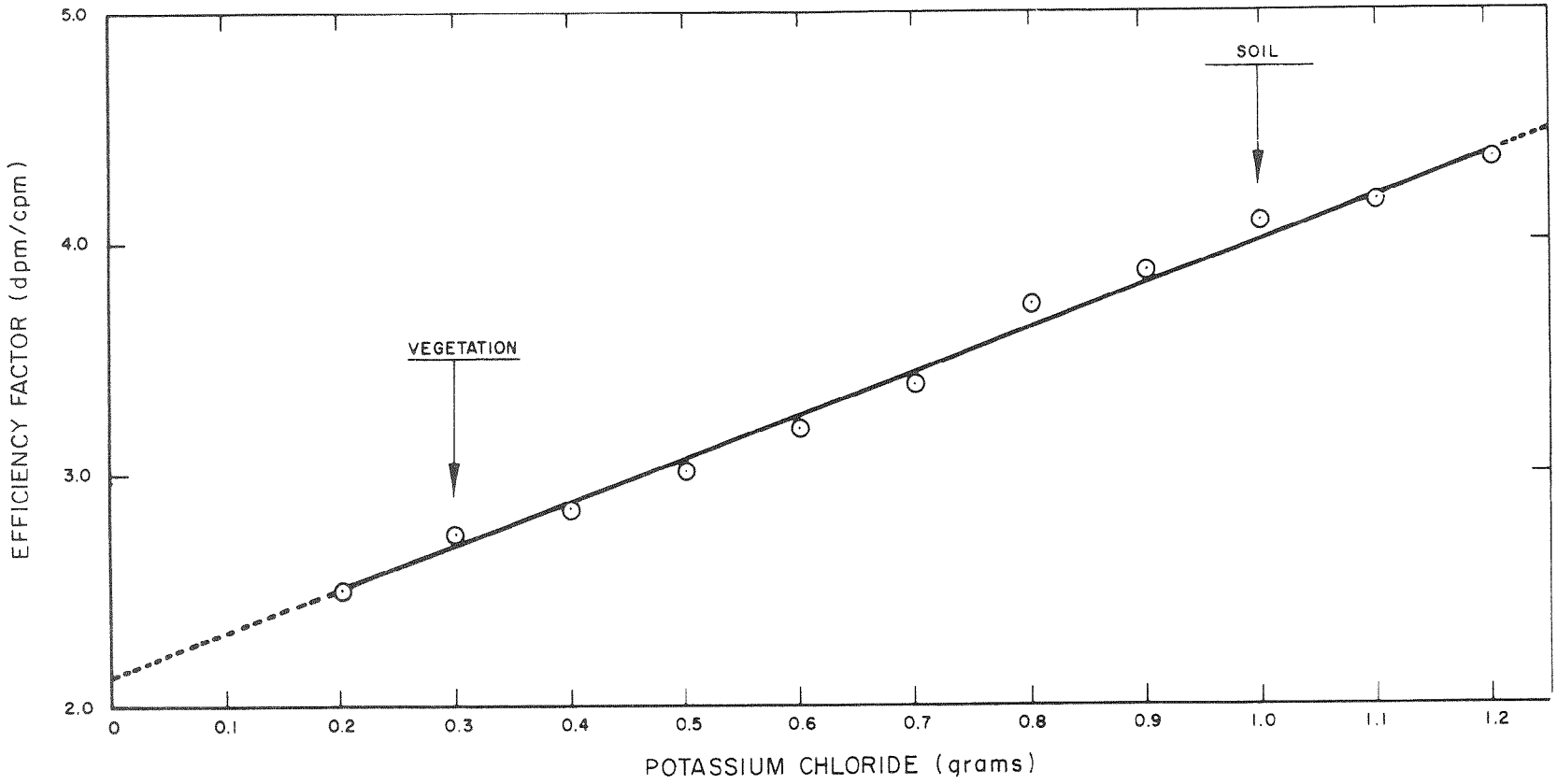

Figure 9. Sample Self-Absorption Correction Graph

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